

# **Guide to Sampling Air, Water, Soil, and Vegetation for Chemical Analysis**

**By**

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**ENVIRONMENTAL HAZARDS ASSESSMENT PROGRAM**

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## **Acknowledgments**

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## **Disclaimer**

The mention of commercial products, their source or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such product.

# TABLE OF CONTENTS

## Page

Acknowledgments . . . . .	i
Disclaimer . . . . .	i
Table of Contents. . . . .	ii
List of Figures . . . . .	iii
Introduction . . . . .	1
 I. AIR SAMPLING . . . . .	 2
II. SURFACE WATER SAMPLING . . . . .	7
III. GROUND WATER SAMPLING . . . . .	11
IV. SOIL SAMPLING . . . . .	17
V. VEGETATION/FRUIT SAMPLING . . . . .	23
VI. REFERENCE MATERIALS . . . . .	26
 APPENDICES . . . . .	 27
Appendix A: A Typical Chain Of Custody	
Appendix B: Commissioner's Request for Analysis	
Appendix C: Special Project Wells Chain of Custody	
Appendix D: Equipment Sources	
Appendix E: Numbering Water Wells in California (Department of Water Resources)	
Appendix F: Routine Notifications When Pesticides are Confirmed in Drinking Water	
Appendix G: Department of Water Resources - District Offices	
Appendix H: Department of Water Resources Well Data, Form 429	
Appendix I: Conversion Tables	

## LIST OF FIGURES

	Page
Figure 1. Types of air samplers.....	4
Figure 2. A typical domestic water well.....	13
Figure 3. Sampling a soil column with a bucket auger.....	20
Figure 4. Soil sampling in furrowed fields.....	21

## **INTRODUCTION**

This sampling guide was developed by the Environmental Hazards Assessment Program (EHAP), Department of Pesticide Regulation (DPR), California Environmental Protection Agency (Cal/EPA). It is intended to serve as an introductory guide to the collection of environmental samples for pesticide residue analysis. We suggest that this guide be supplemented with formal training courses in environmental monitoring. Other objectives, such as monitoring for compliance with California pesticide use regulations, may require sampling methods not included in this booklet.

The materials and techniques described in this booklet are given so that the user may be better equipped to collect high integrity environmental samples for chemical analysis of pesticide residue. Sampling methods should always have the overriding objective of obtaining samples of the highest possible integrity. A high integrity sample should provide, at the time of analysis, the best opportunity of determining the amount of chemical present in that medium as was present at the time the sample was obtained. Sampling should always be conducted with this objective in mind. When sampling for high levels of pesticides, follow label safety precautions.

Outlined in the guide are methods for collecting samples for pesticide residue analysis in air, surface water, ground water, soil, and vegetation. For each of these media, the sampling process is divided into six components: (1) an overview of the medium; (2) equipment and supplies; (3) site selection; (4) collecting the sample; (5) quality assurance/quality control; and (6) shipping and storing the sample. If technical assistance is needed or any questions arise, our staff is available at the following phone number:

**(916) 324-4100**

## I. AIR SAMPLING

### Overview

Air samples are collected by using any one of a number of commercially available sampling pumps. Our program makes use of three general categories of air samplers: High volume (Hi-Vols, Kurz Instruments), low volume (Lo-Vols, Anderson Samplers Inc.), and personal samplers (SKC West) (Figure 1). In general, Hi-Vol samplers have a high ratio of air flow to trapping medium and are used to measure low concentrations of pesticides (parts per billion (ppb) range or less) over long periods of time (1 to 24 hours or more). LoVol samplers have an intermediate ratio of air flow to trapping medium and may be used to measure higher pesticide concentrations, (ppb to parts per million (ppm) range) over shorter periods of time (from less than one hour to 12 hours or more). Low volume personal pumps have a low ratio of air flow to trapping medium and are used for air monitoring or measuring worker exposures at air flows of five liters per minute or less for pesticide concentrations in the high ppm to low ppb range, with run times from a few minutes to 8 hours or more. These are not hard, and fast rules, field conditions often dictate which sampler is best.

All air samplers draw air through a glass or stainless steel cylinder containing a sampling medium capable of trapping the chemical of interest. The various sampling media available consist of numerous sizes and types of sorbent resins, charcoal, and filters. These are used alone or in many combinations. Sampling cylinders for Lo-Vols and Hi-Vols can be prepared from component materials available from various vendors (Appendix D). All materials that will come into contact with samples are prepared by washing, double rinsing with deionized water, rinsing with a solvent (pesticide grade propyl or ethyl alcohol), and heat drying. A variety of pre-packed sorbent tubes, designed for use with the personal samplers, are available through SKC West (Appendix D).

### Equipment and Supplies

You may find the following materials useful for air sampling:

- **EHAP Chain of Custody (COC) (Appendix A) or Request for Analysis Form 531-002 (Appendix B)** to document sampling history from sample generation to final analysis
- **Ball point pens** to fill out paperwork and record field notes.
- **Air Samplers: Lo-Vols or Hi-Vols** for sampling inside or outdoors, **Personal Samplers** for sampling worker exposure or when low volume flows are required (Appendix D).
- **Sampler calibration equipment** for adjusting and correcting flow rates.
- **Sample media** (resin jars and tubes) to collect air samples.
- **Timer** to turn samplers on/off at designated times.
- **Portable generator** to provide power for air samplers.
- **Extension cord** to connect electric source to samplers.
- **Duct tape** to hold extension cords in place.
- **Disposable gloves** to prevent sample contamination.

- **Silicon grease** to attach sample media tubes onto the samplers.
- **Plastic bags** and twist ties to package air samplers.
- **Ice chest** to provide storage and security of samples.
- **Dry ice** to keep air samples cold during shipment and storage.
- **Weather recording instruments** to document wind speed and direction.
- **Field note book** to document personnel, field locations, events, and any other pertinent information.
- **Label tape** to mark and identify sample container with the appropriate COC.

### **Site Selection**

**Air sampling indoors:** Use Lo-Vol or Hi-Vol samplers depending on expected pesticide concentrations. Air samplers produce a moderate noise level during operation and in order to ensure that it will not later become a nuisance, let residents listen to a machine prior to actual sampling.

Hi-Vol samplers should be vented out of the dwelling to ensure that air will not be recycled through the machine causing erroneous results.

Avoid rooms with cigarette smoke or gas appliances; any gases or suspended smoke particles in the area may be trapped in the sampling medium and interfere with chemical analysis.

**Air sampling outdoors:** Hi-Vol or Lo-Vol air samplers may be used in outdoor situations.

The intake openings for the sampling tubes or jars should always be positioned to avoid exposure from engine exhausts, running motors, cigarette smoke, or any other non-target air contaminants.

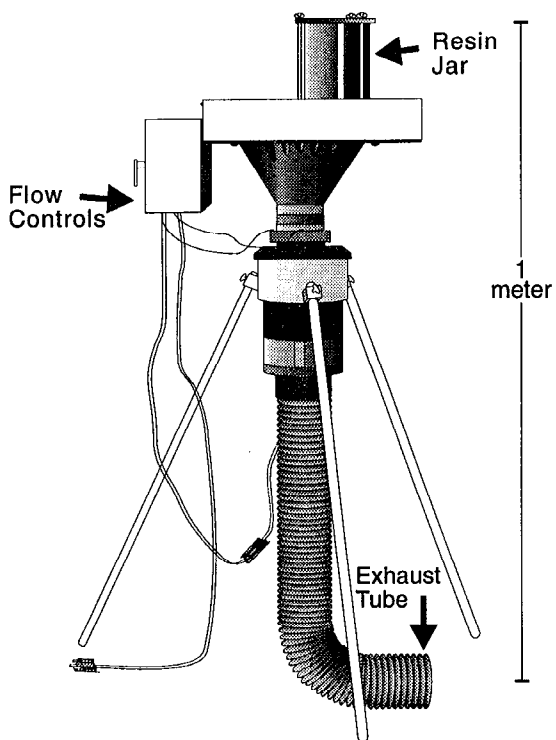
Protect samplers from rain and direct pesticide spray by using shelter hoods and by mounting sample tubes in a horizontal position.

Choose an area where the equipment will remain secure and not be subject to vandalism. The use of automatic timers to turn the samplers on and off may enable samplers to be used in some otherwise inaccessible locations. An example would be an area that is locked and only accessible during certain hours.

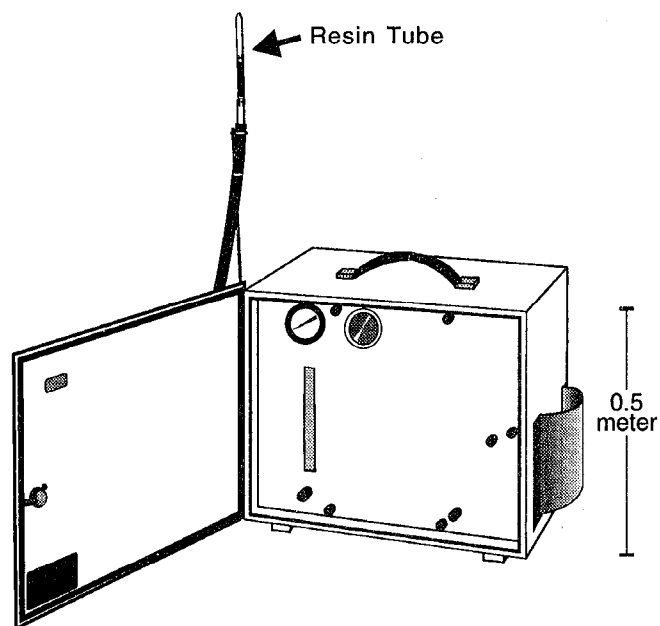
### **Collecting the Sample**

A hands-on practice session may be necessary prior to operating air sampling equipment.

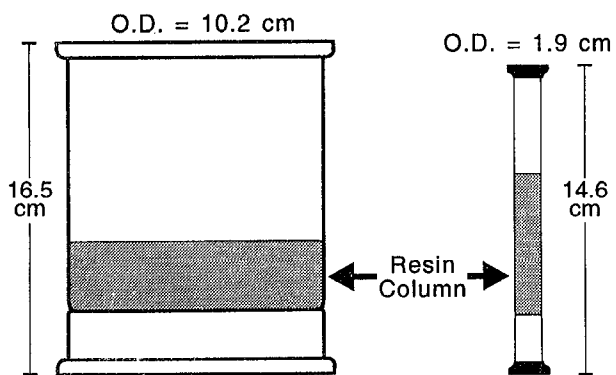
Determine the best trapping medium for the chemical of interest by consulting with the analytical lab, scientific literature, or sampling material guides available from vendors such as SKC West (Appendix D).



High Volume (HI-VOL) Air Sampler  
Kurz Instruments

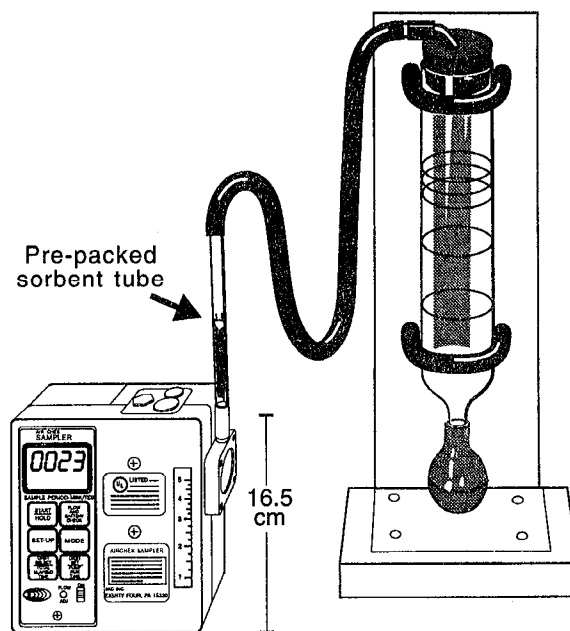


Low Volume (LO-VOL) Air Sampler  
Anderson Samplers, Inc.



HI-VOL  
Resin Jar  
(125 ml Resin)

LO-VOL  
Resin Tube  
(15 ml Resin)



Low Flow Personal  
air sampler  
SKC Inc.

Bubble Calibrator  
SKC Inc.

Figure 1. Types of Air Samplers



Use a new pair of disposable latex, plastic, or rubber gloves when handling sampling materials. Sample tubes and jars can be wrapped with aluminum foil to help prevent chemical breakdown by sunlight.

Be certain that the electrical power source is reliable; use portable generators when necessary and position them a sufficient distance away to avoid drawing exhaust fumes into sample containers.

When sampling air to determine the concentration of a chemical due to an application, it is best to determine background levels of that chemical immediately prior to the pesticide application. If possible, background air samples should run a length of time equal to the longest anticipated post application period sample.

Typical sample run times may vary from less than one hour to 24 hours or more; the distance from the pesticide source to the sampler site can vary but is generally within 100 meters, and the flow rate of a sampler can range from milliliters per minute to 1000 liters per minute or more. For a very general rule of thumb, expected concentrations in the parts per trillion (ppt) to low ppb range would indicate a choice of longer run times, shorter distances from pesticide source to sample sites, and higher flow rates. Expected concentrations in the high ppb to ppm range would indicate shorter run times, longer distances from pesticide source to sample sites, and lower flow rates. It is useful to document wind speed and direction during all sampling periods for outdoor air sampling, as the relationship between these parameters and sampler location will aid in interpreting pesticide concentration values.

Fill out a Chain of Custody (COC) form (Appendix A), or a Request for Analysis (Form 531-002) (Appendix B) for air samples. A COC is a legal form that is signed by all persons handling a sample and documents the custody of a sample from the time the sample container is prepared to the time the sample is analyzed. Make sure that all sample tubes are correctly marked and matched with the appropriate COC. Record other information on the COC including: the date and time sampler is started and stopped, persons collecting sample, flow rate of sampler, machine number, location of sampler, chemicals to be analyzed, and any other information that may affect the integrity of the sample.

#### **Quality Assurance/Quality Control (QA/QC)**

QA/QC samples are incorporated into air sampling investigations in order to enhance sample integrity, increase the confidence of analytical data, and to prevent false positives caused by contamination.

One type of sample that can be easily incorporated into an air sampling study is a "trip blank." A trip blank is a sample tube that is uncapped and recapped at the sample site, stored and transported with the other sample tubes, and submitted to the lab for analysis. The resulting expected "nondetected" (ND) analysis would increase the confidence that samples were not contaminated during preparation, shipping, storage or analysis.

In the process of extracting and analyzing the air samples, the lab should perform its own internal QC. When negotiating with the lab prior to submitting samples, request that they provide a copy of the internal QC performed with your samples and include this information in your report.

#### **Shipping and Storage**

Fit the open ends of the sample tubes with rubber stoppers or plastic caps and place in plastic bags. If resin jars are used, double wrap the jars in plastic bags and secure with rubber bands.

Immediately place samples in a container with dry ice. Place cardboard or paper on top of sample containers then place the dry ice on top to prevent breakage and to maximize cooling.

Ship and store air samples on dry ice (-70°C) until analysis. Less volatile compounds will store well at standard freezer temperatures of -10°C. Consult the analyzing chemist to determine the volatility or storage stability of the pesticide of interest.

It is preferable to store pesticide residue samples at -70°C. If dry ice is not available, use any form of refrigeration in the following order of desirability: 1) freezer, 2) refrigerator, 3) blue ice, 4) wet ice.

Always use an ice chest or container that has never been used to store concentrated pesticides or diluted formulations.

## II. SURFACE WATER SAMPLING

### Overview

Most surface water samples are collected by filling new, one-liter, narrow neck, amber glass bottles with Teflon®-lined caps. Bottles used previously are washed with detergent, double-rinsed with distilled water, rinsed with pesticide grade ethyl or propyl alcohol, and oven dried. If Teflon®-lined caps are not available, caps can be lined with aluminum foil to prevent contamination. Any type of one-liter glass containers with foil-lined caps, prepared as described, can be substituted as sample containers, and any of the sampling items listed below must also be prepared in this manner if they will come into contact with the sample. Some pesticides may bind to glass surfaces and must be collected in some other type of container. Consult with the analytical laboratory before choosing the type of container. We recommend using new containers whenever possible.

### Equipment and Supplies

You may find the following materials helpful for surface water sampling:

- **EHAP Chain of Custody (Appendix A) or Request for Analysis Form 531-002 (Appendix B)** to document sample history from sample generation to final analysis.
- **Ball point pens** to fill out paperwork and record field notes.
- New one-liter narrow neck amber glass **sample bottles** with Teflon®-lined caps to contain water samples.
- A **Scoop** or a "**top off jar**" to completely fill sample bottle.
- **Hand pumps** can be useful for sampling water profiles and are available from scientific supply outlets.
- **pH meters** are needed if documenting the acidity of the sample is desired.
- **Preservatives** if required by the analyzing lab for the pesticide of interest.
- Equipment for measuring discharge and velocity of moving water bodies, (Appendix D).
- **Sharpie® pen** or other water-insoluble ink pen for labeling samples.
- **Aluminum foil** may be used to line bottle caps on sample jars that do not have Teflon® seals.
- **Disposable gloves** to help prevent sample contamination.
- **White tape** to label sample jars.
- **Boots or waders.**
- **Ice chest** to transport and store samples.
- **Wet ice** for storing and shipping samples.
- **Field notebook** to document personnel, field locations, events, and any other pertinent information.

### Site selection

Use USGS 7-1/2 minute maps, which have excellent geographic detail, to identify tributaries and topographic features that may have some impact on the sample site.

When collecting from a stream, sample as close as is feasible to the suspected site of pesticide introduction (if known). Collect a composite sample (see page 10) from a transect of the river and submit one-liter sub-samples for analysis. Whenever possible, collect a stream sample prior to a convergent tributary to avoid dilution and channeling. Samples should also be collected from upstream tributaries or any other possible sources of pesticides flowing into the study area.

Collect a sample upstream from the suspected pesticide introduction in order to measure any background levels of the chemical of interest.

Determine the discharge and velocity of the stream and any tributaries. This information can be used to estimate the total mass of the contaminant and the rate of movement downstream. The equipment and methods needed to accurately measure stream discharge are described in Buchanan and Somers (1969). A variety of current velocity meters are available from various vendors. If you do not have equipment designed to measure stream discharge and velocity, you can approximate these measurements with the following formula using the float method described in Buchanan and Somers (1969):

$$\text{Width of stream (feet) x average depth (feet) x speed of flow (feet per second) = flow rate in cubic feet per second}$$

#### **Collecting the Sample**

Use shoulder-length, waterproof, disposable gloves if contact with water may pose a dermal exposure problem due to pesticides.

Prior to collecting the sample (while the bottle is still dry) mark each bottle using white labeling tape with a unique number in order to cross-reference the container with the appropriate COC or Form 531-002. Cover the label with clear tape and press firmly to assure the label will stay on the bottle.

Fill two bottles with water for each chemical or class of chemicals (e.g., organophosphorus). One of these bottles should be kept as a backup to be analyzed at a later time (e.g., primary bottle is lost or broken, or to confirm a positive analysis).

Avoid sampling from areas where water has been isolated from the main body of the stream, lake, or pond. Sample a stream transect while facing upstream; wade out as far as possible into ponds and avoid sampling the sediment that is disturbed by your movement.

After you have selected a sampling location, you can obtain a well-mixed sample by immersing the sample bottle, with the cap on, below the water surface. Remove the cap underwater and allow water to enter the bottle as you move the bottle vertically through the water profile. Avoid skimming the water surface unless that is your intent, (many substances with various degrees of solubility and specific gravity will float on a water surface and the sample may yield a concentration that is not representative of the entire water profile).

Fill bottle completely to eliminate all airspace (if an airspace is present in the bottle, the water-air interface may allow some chemical to vaporize prior to analysis). While the bottle is under water, replace the Teflon®- or foil-lined cap and bring the bottle out of the water.

If the body of water is too shallow to immerse a bottle, use a hand pump to draw water into the sample bottle. If a hand pump is not available, use a smaller, clean, glass container (i.e., a beaker or a jar) as a "scoop" and transfer water to the one-liter amber bottle.

Exercise caution so that the removed bottle cap does not come into contact with possible sources of contamination. A shirt pocket is a good spot to put one; the ground is not.

Several water samples collected throughout a pond or lake are preferable to a single grab sample collected at one location. If resources limit you to one sample, take several equal-size sub-samples from various areas throughout the body of water and pour them into a clean container. Thoroughly mix this **composite sample** and pour into the one-liter amber bottles, use a sample splitter whenever available to obtain a representative water split (Appendix D).

Record all information on a Chain of Custody (Appendix A) or on a Request for Analysis form 531-002 (Appendix B).

#### **Quality Assurance/Quality Control (QA/QC)**

QA/QC samples are incorporated into surface water investigations in order to enhance sample integrity, increase the confidence of analytical data, and to prevent reporting ("false") positives caused by contamination.

One type of QA/QC sample that can be easily incorporated into a surface water study is a "field blank." A field blank is a sample bottle that is prepared with the other bottles, packaged and transported to the sample site, filled with distilled or deionized water at the sample site, stored and transported with the other sample bottles, and submitted to the lab for analysis. The resulting expected "nondetected" (ND) analysis would increase the confidence that samples were not contaminated during preparation, field sampling, shipping, storage or analysis

QC "splits" are duplicate samples poured from a common container (one of the resulting samples from a composite split) at the sample site. Splits are handled the same as the primary samples, but are analyzed by a second laboratory and/or by a second analytical method.

A third type of QC sample is a "blind spike". Blind spikes are samples that are fortified with a known amount of the pesticide of interest and are generally prepared by the primary lab and stored with the field samples. When the field samples are delivered to

the lab, the QC spikes are included as unknowns, accompanied by a fictitious COC. The resulting analyses from split and spiked samples are used to confirm qualitative and quantitative laboratory results.

In the process of extracting and analyzing the field samples, the lab will also perform its own internal QC. When negotiating with the lab prior to submitting samples, request that they provide a copy of the internal QC performed with your samples and include this information in your report.

#### **Shipping and Storage**

Place samples immediately on wet ice (+4°C) for shipping and maintain at +4°C until analysis. Turbid or warm water samples that may have high bacteria populations can be salted with a pre-measured amount of table salt to prevent biodegradation. In some cases, other chemicals may be added or the pH may be adjusted to aid in preserving samples. If you have any question pertaining to, or if you are considering the use of, preservatives for a water sample, contact the laboratory that will do the analysis and discuss these options with a chemist. Addition of preservatives to a sample must be documented on the Chain of Custody or the Request for Analysis forms.

Always use an ice chest or container that has never been used to store concentrated pesticides or diluted formulations.

### III. GROUND WATER SAMPLING

#### Overview

Ground water is usually sampled from existing water wells using new, one-liter, narrow-neck, glass amber bottles with Teflon®-lined caps. Many volatile compounds may require the use of volatile organic analysis (VOA) vials. Previously used bottles are washed with detergent, double-rinsed in distilled water, rinsed in pesticide grade ethyl or propyl alcohol, and oven dried. If Teflon®-lined caps are not available, caps can be lined with aluminum foil to prevent contamination. Any type of one-liter glass containers with foil-lined caps, prepared as described, can be substituted as sample containers, and any of the sampling items listed below must also be prepared in this manner if they will come into contact with the sample. Some pesticides may bind to glass surfaces and must be collected in some other type of container. Consult with the analytical laboratory before choosing the type of container. We recommend using new containers whenever possible.

#### Equipment and Supplies

You may find the following materials helpful for well water sampling:

- **EHAP Chain of Custody (Appendix A) or Request for Analysis Form 531-002 (Appendix B)** to document sample history from sample generation to final analysis.
- **Schrader® samplers** (Fig. 2 inset) made of stainless steel or Teflon® tubing, for sampling through a Schrader® valve.
- Extra **Schrader® valves and valve stems** to replace or repair defective valves.
- **Valve core remover** for removing Schrader® valves.
- **Teflon® tape** to reseal valves and fittings removed for sampling.
- **Adjustable wrench** for removing entire Schrader® valves, pipe plugs, and other fittings.
- Small **locking pliers** for securing Schrader® samplers to the Schrader® valve.
- Small flat **wood sticks** to override the electrical contact points in a pressure switch.
- **Plastic bags** to protect the electric points from contact with water.
- **Duct tape** to secure the plastic bags.
- **Garden hose** to direct water from hose bibs.
- **Five-gallon container** is useful when determining the delivery rate of a water well.
- **Deionized water** is used as the water source for QA/QC field blanks and for rinsing sampling equipment.
- **Alcohol** to rinse out Schrader® sampler tubes.
- **Department of Water Resources (DWR) Well Data Sheet (Form DWR 429)** to assist the DWR in its effort to locate and/or assign a permanent number to the well.
- **Ball point pens** to fill out paperwork and record field notes.
- New, one-liter, narrow-neck, amber glass, **sample bottles** with Teflon®-lined caps to contain water samples.
- **pH meters** are needed if documenting the acidity or basicity of the sample is desired.
- **Preservatives** if required by the analyzing lab for the pesticide of interest.
- **Aluminum foil** may be used to line bottle caps on sample jars that do not have Teflon® seals.

- **Disposable gloves** to help prevent sample contamination.
- **White tape** to label sample jars.
- **Ice chest** to transport and store samples.
- **Wet ice** for storing and shipping samples.
- **Field notebook** to document personnel, field locations, events, and any other pertinent information.
- **Sharpie® pen** or other insoluble marker for labeling sample bottles.
- **Polaroid® camera** to make a descriptive record of the well site.

### **Water Well Site Selection**

Several criteria are listed here that may provide a sample that is representative of the supplying aquifer, and may minimize effects from water well construction. If you have a choice of wells to sample, choose one that meets as many of the following criteria as possible:

- 1) A driller's log for the well is available. Driller's logs contain valuable information about the construction and dimensions of the well at the time of construction including: depth to water-bearing strata; if any strata are sealed off; dimensions of the sanitary seal; placement of screens in the casing; depth of the bore hole; depth to standing water; and descriptions of construction materials.
- 2) Small domestic wells are preferable to large irrigation wells. Generally, domestic wells are drilled shallower, are sealed more carefully, and are less likely to contain contaminants often introduced by lubrication systems found on large turbine pumps.
- 3) A well casing constructed with steel is preferable to plastic or PVC (plastic can interfere with some pesticide analyses). However, more recent well construction is predominantly plastic.
- 4) The presence of a sampling port between the pump and the storage tank is preferable to a sampling port after the storage tank.
- 5) A well that is used regularly is preferred to one that is not in regular use.
- 6) The above-ground equipment and concrete pad should be in good condition. Check for cracks in the concrete pad, openings in the well head, water running into the well head, and storage of pesticides or other chemicals near the well head.



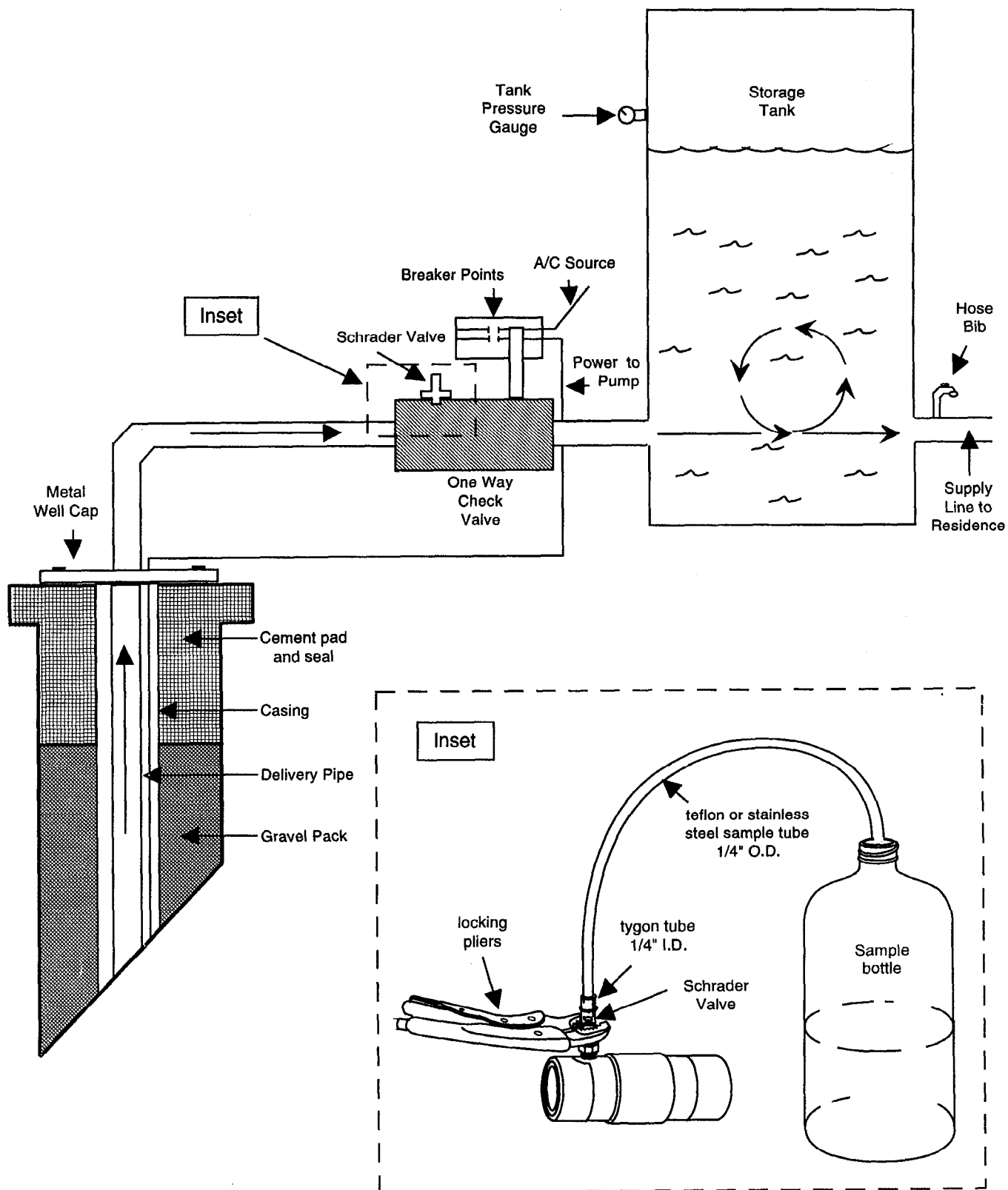


Figure 2. A typical domestic water well.

### **Obtaining the Sample**

These instructions refer to a typical domestic water well shown in figure 2. Allow a well pump to run for a minimum of 10 minutes, or for the equivalent of three casing volumes, prior to taking the sample. When performing a 10-minute flush, open enough hose bibs around the house to ensure that the pressure gauge on the storage tank holds at a steady level below the shutoff pressure such that the pump output rate is equal to the system drain rate. If you are following a protocol that requires flushing three casing volumes, use a five-gallon container and calculate the amount of water delivered in one minute from all the open hose bibs while the system is holding at a steady pressure. Divide the equivalent of three casing volumes (in gallons) by the gallon per minute delivery rate to calculate the needed run time (to calculate casing volume in gallons, use the following formula: multiply  $\pi r^2$  times the height of the standing water column, ( $\pi = 3.14$ ,  $r$  = radius of casing, one  $\text{ft}^3 = 7.48$  gallons)). These procedures will flush out the water which has stood in the casing and draw fresh water from the aquifer.

Every effort should be made to sample water prior to it entering the storage tank. The airspace and increased temperatures inside a storage tank could accelerate dissipation or degradation of many pesticides. If a pretank sample cannot be collected, take the sample from an outlet most closely plumbed to the wellhead. Sampling ports may include pipe plugs, Schrader® valves, faucets, or petcocks. When opening a system through one of these ports, you can interrupt the automatic off and on cycling by opening a circuit breaker, or by placing a thin stick between the breaker points. If you are familiar with typical domestic well equipment, you can follow the steps below to obtain a sample from a Schrader® valve. If not, we recommend that you call a qualified well repair person for assistance, or call one of our field staff for more detailed information.

#### **Sampling from a Schrader® valve:**

After running the pump for the desired time, turn faucets off and turn power to "pump off" (either by turning the main pump breaker switch to the off position or by interrupting the current through points).

If you must interrupt the current at the points, cover the point box with a plastic bag and secure with duct tape. Water in the points will short circuit the points and may damage the system.

Remove core from Schrader® valve and attach a **Schrader sampler**, (Tygon® with Teflon® or stainless steel tubing) and secure with locking pliers (Figure 2, inset).

Resume power to pump and fill sample bottles with water (the pump must be running in order to sample from the Schrader® valve). It may be necessary to leave some faucets on in order to keep the pump running. You may want to use a garden hose to direct water to an area where it will not pond up or create a problem for the homeowner.

After you have filled all of the sample bottles, turn off the power to the pump, replace the core in Schrader® valve and resume power to the pump.

Open faucets to reduce the pressure in the storage tank until the pump turns on, then close the faucet and allow the pump to run through one complete cycle to check that it is turning off and on properly and that there are no water leaks from the Schrader® valve core.

Record information on a well water Chain of Custody (Appendix C). If the well does not have a California Well Number, fill out a Well Summary Sheet (DWR form 429). Appendix E contains a blank DWR form 429. Make a copy of this form and carefully complete the following sections: Owner, Owner Address, Tenant, Tenant Address, Location-County, Township, Range, Section, Well Use. In the box marked "sketch," draw an accurate map of the well location, showing the distance in feet from the well to the center of the nearest two streets (reference and include a copy of the street map or if possible a USGS 7 1/2 minute topographical quadrangle map); north orientation; and any other wells on the property. Fill in any other information on the DWR form 429 that you observed or may have obtained from the well owner such as the casing material, pump type, year drilled or re-drilled, etc. Submit it to the nearest DWR district office. They will assign a well number and send it back to you. For more details on filling out DWR form 429, or for more information on numbering water wells in California, see Appendix E.

#### **Quality Assurance/Quality Control (QA/QC)**

QA/QC field samples are incorporated into ground water investigations in order to enhance sample integrity, increase the confidence of analytical data, and to prevent reporting positives caused by contamination.

One type of QA/QC sample that should be incorporated into ground water studies is a "field blank". A field blank is a sample bottle that is prepared with the other bottles, packaged and transported to the sample site, filled with distilled or deionized water at the well water sampling site, stored and transported with the other sample bottles, and submitted to the lab for analysis. The resulting expected "nondetected" (ND) analysis would increase the confidence that samples were not contaminated during preparation, field sampling, handling, shipping, storage, or analysis.

QC "splits" are duplicate samples poured from a common container at the sample site. Splits are handled the same as the primary samples, but are analyzed by a second laboratory and/or by a second analytical method.

"Blind spikes" are samples that are fortified with a known amount of the pesticide of interest and are generally prepared by the primary lab and stored with the field samples. When the field samples are delivered to the lab, the QC spikes are also included as unknowns, accompanied by a fictitious COC. The resulting analyses from split and spiked samples are used to confirm qualitative and quantitative laboratory results.

In the process of performing the analyses on the field samples, the lab will also perform its own internal QC. When negotiating with the lab prior to submitting samples, request that they provide a copy of the internal QC performed with your samples and include this information in your report.

### **Shipping and Storage**

Immediately after filling containers, refrigerate well water samples for shipping and storage until analysis. Typical ice chest temperature of +4°C is preferable for storing samples in one-liter, amber glass bottles. However, some pesticide compounds may require freezing at -10°C or subfreezing temperatures to -70°C (dry ice), in these cases, a polycarbonate, polypropylene, or polyethylene bottle may be appropriate. In some situations, well water samples can be salted with a pre-measured amount of table salt to prevent biodegradation. In some cases, other chemicals can be added or the pH can be adjusted to aid in preserving samples. If you have questions pertaining to preservatives, storage temperatures, and sample container type for ground water samples; or if you need information regarding storage stability of the chemical of interest, contact the laboratory that will do the analysis. Remember to document addition of preservatives on the Chain of Custody or Request for Analysis form.

Always use an ice chest or bottle that has never been used to store concentrated pesticides or diluted formulations.

## IV. SOIL SAMPLING

### Overview

All soil and sediment samples are collected in one-quart, glass Mason jars. New jars need not be washed. Previously used jars are washed with detergent, double-rinsed in distilled water, rinsed in pesticide-grade ethyl or propyl alcohol, and oven dried. Mason jar lids should be lined with aluminum foil. All tools that come in contact with soil samples should be washed with detergent, rinsed in distilled water, and rinsed with alcohol prior to each sampling. Stainless steel is a good choice for shovels, buckets, and other sampling equipment.

### Equipment and Supplies

You may find the following materials useful for soil sampling:

- **EHAP Chain of Custody (Appendix A) or Request for Analysis Form 531-002 (Appendix B)** to document sample history from sample generation to final analysis.
- **Soil augers** (Fig. 3), soil sampling tubes, slide hammer, and extruder or Acker® soil sampler, or other device to obtain soil cores.
- **PVC pipe** 4 inch inside diameter (ID) x 12 inches long to line the bore hole when using a bucket auger.
- **Rubber mallet** and 12 inch 2 in. x 4 in. wood blocks are used for inserting the PVC pipe.
- **Shovels** for taking soil samples may come in handy when all else fails.
- **Mixing containers** such as stainless steel buckets or large bags are useful when mixing composite samples.
- **Sample jars** for collecting, storing, and shipping samples.
- **Aluminum foil** to line sample jar lids.
- **White Labeling tape** to mark sample jars.
- **Cellophane tape** to seal over labeling tapes.
- **Ice chests.**
- **Dry ice** for storing and shipping soil samples.
- **Detergent** for cleaning equipment.
- **Cleaning brushes** to remove soil from sample equipment between samples.
- **Five-gallon buckets** or other suitable containers to hold wash and rinse solutions.
- **Alcohol** to decontaminate sample equipment after washing.
- **Distilled water** in sufficient amounts to rinse all sample equipment prior to collecting each new sample.
- **Wash bottles** for dispensing alcohol and water.
- **Paper towels** to aid in drying sampling equipment.
- **Disposable gloves** to prevent contamination and exposure to chemicals.
- **Boots**, in case the going gets muddy.
- **Sharpie® pen**, permanent marker, to label sample jars.
- **Field notebook** to document personnel, field locations, events, application history, and any other pertinent information.

### **Site Selection**

If you have a choice, always try to randomize the selection of sample sites within a field. Keep in mind that some fields may have pesticide applications that, by intent, are not uniformly applied; in these cases, some areas in the field will have higher concentrations of chemicals.

### **Obtaining the Sample**

#### **Surface soil sampling:**

Randomize soil sampling sites throughout a field. Take a composite soil sample: collect a pint of soil from 5 to 10 sites throughout the field, combine these sub-samples in a large bucket or plastic bag. Mix sample thoroughly, fill the one-quart sample jar, and discard the remaining soil.

Always wash sampling equipment before collecting each new sample that is not part of a composite sample. Remove all soil by washing with detergent and water, rinsing with distilled water, then rinsing with ethyl alcohol if available. Isopropyl alcohol can be used as a substitute. It is not necessary to wash sampling equipment while collecting sub-samples for a composite sample.

A soil sample marked "surface soil down to a maximum of five centimeters (cm.)" means that the sample contains soil taken from zero (soil surface) to five cm. deep. This sample can be collected with a hand trowel, shovel, pick, etc. A soil sample marked "zero to five cm. core" indicates that the sample was collected using a coring device which is driven into the ground and contains an equal amount of soil from the one, two, three, through five cm. depth. Indicate on the Chain of Custody which method was used to collect the soil sample.

#### **Sampling soil to shallow depths:**

Our program utilizes hand operated soil augers (also referred to as bucket augers) to sample soil down to a depth of 3 meters (Fig. 3). For sampling depths of one meter or less a variety of commercially available soil tubes can be used. Before digging, provide a detailed site map and check with local municipalities if the possibility of underground lines exist.

To sample the top 15 cm. (6 inches) of soil with a bucket auger:

Using a rubber mallet, drive a cylindrical PVC plastic sleeve into the soil to a depth of approximately 15 cm. (This first step is only necessary when sampling loose sandy soils, or when surface concentrations of suspected contaminants are expected to be high.)

The first 15 cm. sample is obtained by screwing the auger through the sleeve to the desired depth, then retrieving the auger and shaking the entire sample into a plastic bag. The sample can then be mixed in the bag and poured into a glass jar. If a composite sample is desired, all sub-samples from ground level to 15 cm. can be mixed in a bag and the resulting composite sample poured into a glass jar. Discard excess soil.

To sample deeper increments, manually remove excess soil from inside the sleeve to the 15 cm. depth wearing a clean plastic glove. The auger is then cleaned in soapy water, triple rinsed in deionized or distilled water, then rinsed with alcohol.

Subsequent samples are taken through the sleeve generally in 15 cm. increments; soil is not manually removed from the borehole for these subsequent samples.

Most of the loose soil that may have dropped into the borehole, and is now in the top end of the auger, can be removed from the filled bucket auger by striking the bucket with a rubber mallet while holding the auger parallel to the ground.

The procedures for mixing sub-samples in a plastic bag and pouring samples into jars is then repeated. Remember to line lids with foil. If the field to be sampled is shaped with furrows and beds, keep in mind that chemicals may have been applied in narrow bands. Thus, you may need to use a shovel to remove sections of soil perpendicular to the direction of furrows to ensure that the sample submitted will be representative of the field (Fig. 4). Sample soil to a depth of 5 to 10 cm. below the label application depth for the suspected pesticide. You may get inaccurate results if you use soil augers or soil coring tubes to sample a field that has been banded or spot treated.

#### **Quality Assurance/Quality Control (QA/QC)**

QA/QC field samples are incorporated into soil sampling investigations in order to enhance sample integrity, increase the confidence of analytical data, and to prevent reporting positives caused by contamination.

A "rinse blank" is a water sample collected by capturing distilled or deionized water that is poured over all the components of the soil sampling equipment. The rinse sample is collected after the equipment is cleaned according to directions in "**Obtaining the sample,**" paragraph 2, and prior to using the equipment to collect a soil sample. The rinse blank is then stored and transported with the other sample bottles and submitted to the lab for analysis. A "nondetected" (ND) analysis of a rinse blank would indicate that the cleaning procedures were adequate for preventing cross contamination from the sampling equipment.

Another type of QA/QC sample that can be incorporated into a soil sampling study is a "split." A pre-determined number of field samples are submitted to the primary lab with instructions to thoroughly mix the sample, split into two sub-samples, and analyze one sample. The other half of the split is then analyzed by a second lab. The resulting two analyses can then be compared.

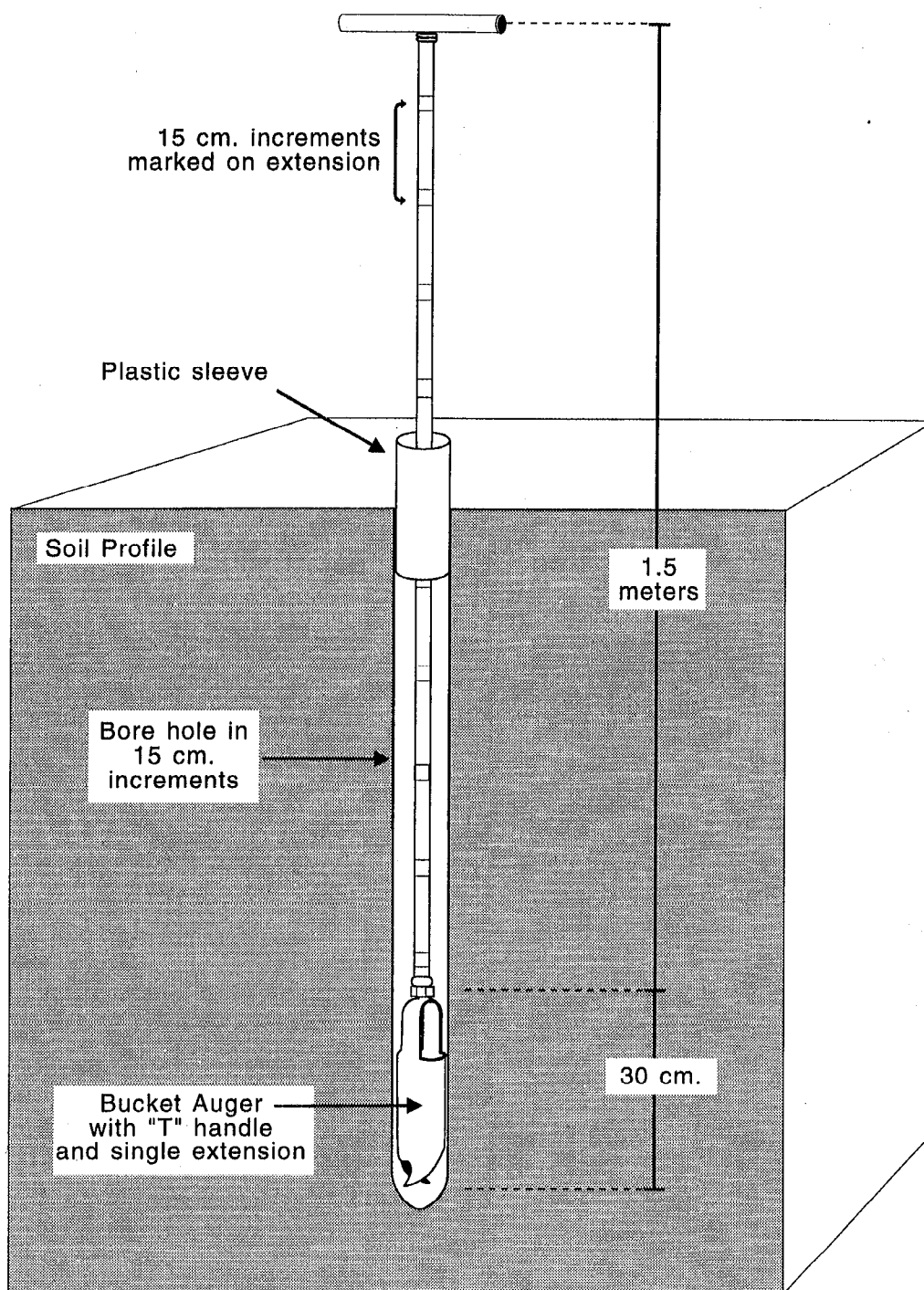
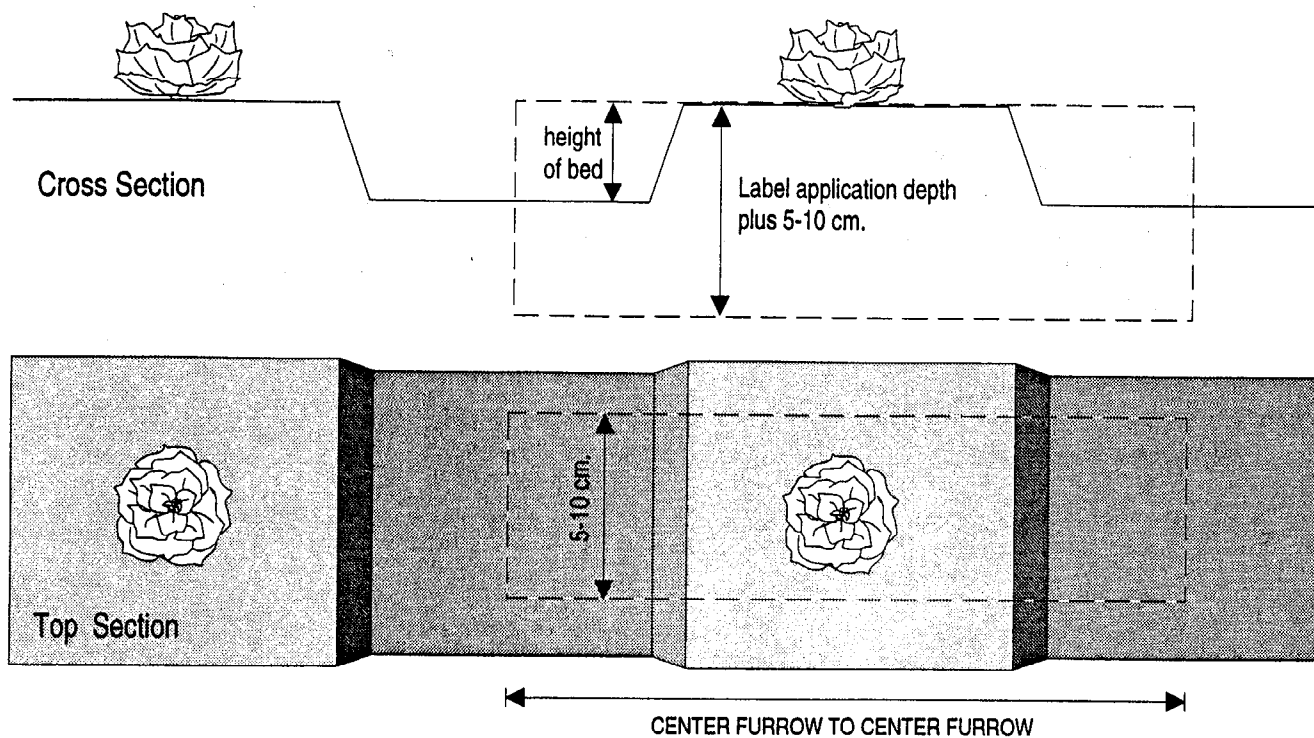


Figure 3. Sampling a soil column with a Bucket Auger.



### A. SINGLE ROW BEDS:

COMBINE SOIL, FROM THE IMAGINARY AREA OUTLINED IN FIGURE A OR B, IN A CONTAINER AND FILL A 1 QUART JAR.



### B. DOUBLE ROW BEDS

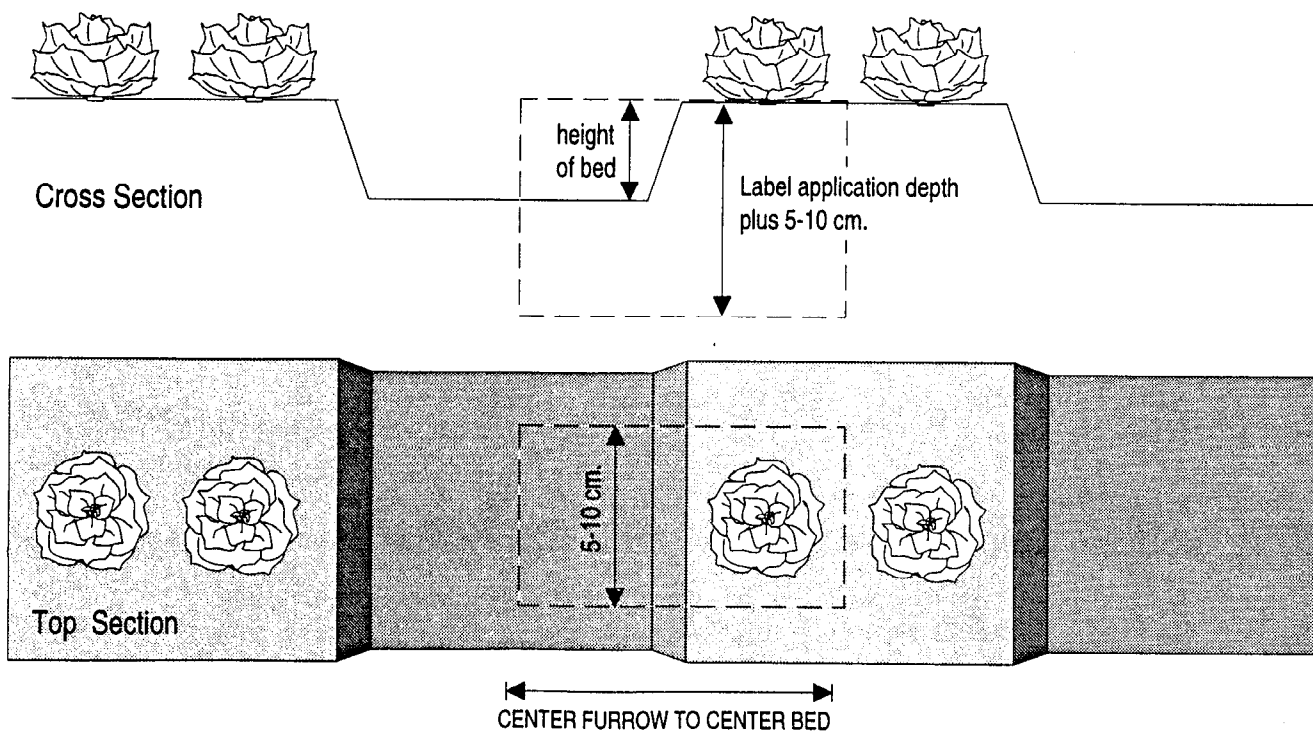


Figure 4. Soil Sampling in Furrowed Fields

A "blind spike" is a soil sample that is fortified with a known amount of the pesticide of interest and mixed thoroughly on a roller. Matrix spikes are submitted as unknown to the lab accompanied by a fictitious COC. The resulting analyses from splits and matrix spikes are used to confirm qualitative and quantitative laboratory results.

In the process of performing the analyses on the field samples, the lab should also perform its own internal QC. When negotiating with the lab prior to submitting samples, request that they provide a copy of the internal QC performed with your samples and include this information in your report.

### **Shipping and Storage**

Ship soil samples at  $-70^{\circ}\text{C}$  (dry ice). Store soil samples in a freezer. Ship and store rinse blanks at  $+4^{\circ}\text{C}$  (wet ice or refrigeration).

## V. VEGETATION/FRUIT SAMPLING

### Overview

Vegetation may be sampled to determine dislodgeable residues and/or total residue. Dislodgeable residues are determined by analyzing residues from the surface of the foliage. The results are reported as a weight-to-surface area ratio. Total residue is determined by extracting and analyzing surface and internal residues from the vegetation sample, and the results are reported as a weight-to-weight ratio. When sampling for total residue, collect leaves in one-quart Mason jars or, for smaller samples, in one-pint jars. If you are using a leaf punch designed for collecting dislodgeable residue samples, the leaves are collected in the glass container screwed on to the punch. Cap off the container after the sample is collected and screw a new jar on to the leaf punch to collect the next sample.

Jars that are re-used should be washed with detergent, double rinsed in distilled water, rinsed in pesticide-grade ethyl alcohol, and oven-dried. New jars do not need to be cleaned. Caps should be lined with aluminum foil. All tools that come in contact with vegetation should be washed with detergent, rinsed in distilled water, and rinsed with ethyl alcohol prior to collecting each sample. We recommend using new containers for residue sampling.

### Equipment and Supplies

Materials that you may find useful for vegetation/fruit sampling:

- **Request for Analysis Form 531-002 or EHAP Chain of Custody** to document sample history from sample generation to final analysis.
- **Glass jars or plastic bags** to contain samples during shipment and storage.
- **Disposable gloves** to prevent contamination of samples and to prevent chemical exposure.
- **Scissors** for removing vegetation from plants.
- **Leaf punch** for collecting dislodgeable residue samples.
- **Ladder** for sampling taller trees.
- **Pole picker** for reaching fruit high in trees.
- **Aluminum foil** to seal sample jar lids.
- **Detergent** for washing sampling equipment.
- **Alcohol and distilled water** to rinse sampling equipment.
- **Wash bottles** for dispensing alcohol and water.
- **Labeling tape** to mark sample bottles.
- **Clear cellophane tape** to seal labeling tape.
- **Ice chest and dry or wet ice** for storage and shipment of samples.

### Site Selection

**Sampling leaves from trees and shrubs:**

Choose a plant that has enough foliage to provide sufficient material for the duration of the monitoring period.

To estimate the average concentration of a chemical over the entire plant, your sample should include foliage from all locations on the plant including the top, bottom, inside, and outside of all the sides.

To determine the direction of possible pesticide drift, take separate samples from the north, south, east, and west sides of the plant.

**Sampling a row or field crop:**

Randomly collect leaves from all sides of several plants, from different areas of a field and do not include leaves that have contacted the soil.

When sampling vegetation for a period of days (i.e., if the purpose of the investigation is to determine the dissipation rate of a pesticide over time), keep in mind that new growth after the chemical application may affect the results of the analysis.

**Obtaining the Sample**

**Leaf samples:**

Handling - Use a clean pair of disposable gloves when handling vegetation samples to prevent exposure to chemicals and to prevent cross-contamination of other samples. Handle leaves as little as possible. Always use clean scissors and, when possible, cut leaves off directly into the sample container. Leaf punches can also be used to obtain samples for dislodgeable residue analysis.

Sample Size - A reasonable number of leaves for a single sample is 30-40 small leaves, 20-25 medium leaves, and 15-20 large leaves. If a leaf punch is used, take 40-60 discs per sample and record the exact number on the COC.

Containers - Polyethylene bags are convenient containers for leaf samples but may not be suitable for all pesticides. Whenever possible, glass containers with foil-lined lids are recommended and, if requesting dislodgeable analyses, glass containers are required (a container rinse is part of the extraction process).

**Fruit Samples:**

Handling - Use a clean pair of disposable gloves when handling fruit samples.

Sample Size - One pound is a reasonable sample size.

Methods - The sample will be more representative if it contains fruit collected from several areas of the field. When sampling plant parts that grow above ground, avoid parts which come in contact with soil. When sampling plant parts that grow underground, such as sugar beets or potatoes, extra precautions must be taken to avoid piercing the underground stem or root with sampling tools because the surrounding soil may contain pesticides in concentrations high enough to contaminate the sample. Wash samples which grow underground before placing them in the sample container (to avoid contamination by pesticide-laden soil), but do not wash fruits which grow above ground.

Containers - Fruits (including nuts) should be packaged in glass containers whenever possible. Plastic bags may be used if the sample is too large. Submit whole fruit unless instructed otherwise.

#### **Quality Assurance/Quality Control (QA/QC)**

QA/QC samples are incorporated into vegetation/fruit (V/F) sampling investigations in order to enhance sample integrity, increase the confidence of analytical data, and to prevent reporting positives caused by contamination.

One type of QA/QC sample that can be incorporated into a V/F sampling study is an "extract split." It would be difficult to maintain homogeneity with a split field V/F sample. Instead, the sample is divided into two parts after the extraction has been completed by a chemist. One of the two extracts is analyzed at the primary lab; the other is sent to a second QC lab.

In the process of performing the analyses on the V/F field samples, the lab should also perform its own internal QC. When negotiating with the lab prior to submitting samples, request that they provide a copy of the internal QC performed with your samples and include this information in your report.

#### **Shipping and Storage**

If vegetation is to be analyzed for dislodgeable residue, samples should be shipped and stored at +4°C (wet ice/refrigeration). Indicate on the Chain of Custody that leaves should be saved so that the surface area may be determined. When a leaf punch is used, record the number and size of the punches on the paperwork.

If vegetation is to be analyzed for total residue, samples should be shipped at -70°C (dry ice), and stored at -10°C (freezer). Indicate on the Chain of Custody that the sample is to be analyzed for total residue.

In some instances it may be desirable to divide a total residue sample into a dislodgeable and internal residue analysis. In this case the sample is shipped and stored at +4°C (wet ice/refrigeration).

As with other residue samples, always use an ice chest that has never contained pesticides or diluted formulations.

## VI. REFERENCE MATERIALS

Buchanan, T.J. and W.P. Somers. 1969. Discharge measurements at gaging stations. *In* Techniques of Water-Resources Investigations of the United States Geological Survey. Book 3, Chapter A8. 65 pg.

Biggar, J.W. and J.N. Seiber. 1987. Fate of Pesticides in the Environment. Proceedings of a Technical Seminar. Publication 3320. To order this publication, write to: Division of Agriculture and Natural Resources, University of California, 6701 San Pablo Avenue, Oakland, California 94608-1239

Keith, L.H. 1991. Environmental Sampling and Analysis: A Practical Guide. Lewis Publishers, Inc. 121 South Main Street, Chelsea, Michigan 48118.

## **APPENDICES**

- A. A Typical Chain Of Custody
- B. Commissioner's Request for Analysis
- C. Special Project Wells Chain of Custody
- D. Equipment Sources
- E. Numbering Water Wells in California (Department of Water Resources)
- F. Routine Notifications When Pesticides are Confirmed in Drinking Water
- G. Department of Water Resources - District Offices
- H. Department of Water Resources Well Data, Form 429
- I. Conversion Tables

**APPENDIX - A**  
**A TYPICAL CHAIN OF CUSTODY**



CALIFORNIA STATE  
DEPARTMENT OF  
PESTICIDE REGULATION

CHAIN OF CUSTODY RECORD  
(use ball point pen only)

APPENDIX A  
ENVIRON. MONITOR. & PEST MGMT.  
ENVIRON. HAZARDS ASSESSMENT  
1220 N STREET, ROOM A-149  
SACRAMENTO, CA 95814

30-034 (1/92)

Study #		Sample #		Date On				Date Off				Person Collecting	County #	Location Code	Sample Type																								
				Mo	Day	Yr	Time On	Mo	Day	Yr	Time Off																												
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

Replicate #	Companion #	Flow Rate	Spray Sequence #	Sampling Interval																																			
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

Partner:	Location:	<b>Lab Results</b>		(Save Extracts)
Machine #		Chemical	Amount	Detection Limit
Remarks				
<p><b>Key</b></p> <p>Col 1                      Col 38-40 (Sample Type)</p> <p>S = Spike              LOV = Lo-Vol              SOI = Soil</p> <p>                             FOL = Foliage              WAT = Water</p> <p>                             FAL = Fallout              FRU = Fruit</p> <p>Col 2                      HIV = Hi-Vol              TAN = Tank</p> <p>* = Split                      DRO = Droplet Size</p>				
		Extracted by:	Extraction Date:	
		Analyzed by:	Analysis Date:	
		Approved by:	Report Date:	

Task	Relinquished by	Received by	Date/Time
Container Prepared			
Collect/Transport			

Lab Name	Received for by lab	Date/Time	Logged in by	Date/Time	Lab #

**APPENDIX - B**  
**COMMISSIONERS REQUEST FOR ANALYSIS**

STATE OF CALIFORNIA  
DEPARTMENT OF FOOD AND AGRICULTURE  
Chemistry Laboratory Services

REQUEST FOR ANALYSIS AND REPORT OF ANALYSIS  
ON MATERIALS SUBMITTED BY  
COLLABORATING PUBLIC AGENCIES

531-002 (REV. 3/80)

**NOTICE:** This form will be returned to you. Please type or print your address legibly with black ink and fill out form as completely as possible.

LABORATORY NO. \_\_\_\_\_

Date Received \_\_\_\_\_

(For Laboratory Use Only)

Agency Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_

State \_\_\_\_\_

Zip \_\_\_\_\_

cc Requester  
Pesticide Enforcement (2)

(Please use address of collaborating agency only)

☐ Check if custody record is required

Sample consists of \_\_\_\_\_

Sample identification marks \_\_\_\_\_

Location/source of sample \_\_\_\_\_ County \_\_\_\_\_

Detailed description of problem \_\_\_\_\_

I hereby certify that the analysis requested is necessary in connection with matters relating to my official duties.

Sample Priority  
(From Back)

- ☐ # 1  
☐ # 2  
☐ # 3

Basis for Sample (Alleged Problem)

- ☐ Human Health Hazard  
☐ Plant Symptoms or damage  
☐ Animal/bee illness/loss  
☐ Environmental Effects

By \_\_\_\_\_

Title \_\_\_\_\_

Date \_\_\_\_\_

State specific analysis requested

Laboratory Findings

Requested Disposition of Remaining Sample

☐ Results Phoned

By \_\_\_\_\_

Chemist \_\_\_\_\_

Date \_\_\_\_\_

Date \_\_\_\_\_

**NOTE:** The "Pesticide Enforcement Manual" published by the Department of Food and Agriculture contains information on proper sample size.

[illegible]

**APPENDIX - C**

**SPECIAL PROJECT WELLS CHAIN OF CUSTODY**

CALIFORNIA STATE  
DEPARTMENT OF  
PESTICIDE REGULATION

CHAIN OF CUSTODY RECORD  
(use ball point pen only)

ENVIRON. MONITOR. & PEST MGMT.  
ENVIRON. HAZARDS ASSESSMENT  
1020 N STREET, ROOM 161  
SACRAMENTO, CA 95814

30-032 (Rev. 5/94)

Study #	Sample #	1 County	2 Well Number			3 Sequence Number	4 Meridian	5 D/Z Code	8 Date Sampled			Time	13 Lab Code	22 Well Use
			Twn	Rng	Sec				Mo	Day	Yr			

Person Collecting

Well Owner's Name

LAB RESULTS:

(Save Extracts)

Partner

Minutes Pumped

Temp.

pH//adjusted pH

# of acid drops

Location Code

18  
Address #

Street

City

10

11

12

ST. CHEMICAL

9

AMOUNT  
p.p.b.DETECTION  
LIMIT
☐ \_\_\_\_\_ ( )        
☐ \_\_\_\_\_ ( )        
☐ \_\_\_\_\_ ( )        
☐ \_\_\_\_\_ ( )        
☐ \_\_\_\_\_ ( )        
☐ \_\_\_\_\_ ( )        

REMARKS:

Primary =

Backup =

Backup =

Backup =

Backup =

Field Blank =

20

19

14

Well Depth	Top Perf.	Bottom Perf.	P/N	Reserved	Analytical Method

Extracted by:

Extraction Date:

Analyzed by:

Analysis Date:

Approved by:

Report Date:

Task	Relinquished by	Received by	Date/Time
Container Preparation			
Collect/Transport			

Lab Name	Received for lab by	Date/Time	Logged in by	Date/Time	Lab #

Distribution: White to CDPR lab liaison, Yellow retained by lab, Pink to field files.

**APPENDIX - D**  
**EQUIPMENT SOURCES**

## **EQUIPMENT SOURCES**

### **AIR SAMPLER SUPPLIES**

Kurz Instrument Inc.  
P.O. Box 849  
20 Village Square  
Carmel Valley, California 93924  
(800) 4-237350(800)4-AIRFLO

HI-Q Environmental Products  
Company  
P.O. Box 2847  
La Jolla, California 92038-2847

Anderson Samplers Inc.  
4215 Wendell Drive  
Atlanta, Georgia 30336  
(800) 241-6898

SKC West  
P.O. Box 4133  
Fullerton, California 92634-4133  
Inside California: (800) 228-4103  
Outside California: (714) 992-2780

### **SOIL AND STREAM SAMPLING EQUIPMENT**

Acker Drill Company, Inc.  
P.O. Box 830  
Scranton, Pennsylvania 18501  
(717) 586-2061

Arts Manufacturing & Supply  
(For soil augers)  
105 Harrison  
American Falls, Idaho 83211  
(800) 635-7330

Forestry Suppliers, Inc.  
(For soil probes & stream velocity meters)  
205 West Rankin St.  
Jackson, Mississippi 39204-0397  
(800) 647-5368  
(303) 433-7101

Geotech Environmental Equip. Inc.  
(For water splitter)  
1441 West 46th Avenue  
Unit #17  
Denver, Colorado 80211-2307

Wildco Sampling Equipment  
Wildlife Supply Co.  
(for aquatic sediment sampler)  
301 Cass Street  
Saginaw, Michigan 48602  
(517) 799-8100

### **MISCELLANEOUS EQUIPMENT AND SUPPLIES**

Consult the yellow pages of the nearest metropolitan area phone book for a list of scientific equipment supplies.



**APPENDIX - E**

**NUMBERING WATER WELLS IN CALIFORNIA (DWR)**

## NUMBERING WATER WELLS IN CALIFORNIA

### Need and Responsibility for Well Numbering

The need for a systematic and uniform procedure for numbering wells in California should become apparent when one realizes that (1) over 1,000,000 wells of all shapes, sizes, and condition are to be found in our State and on the average 10,000 to 25,000 more wells are added to this total each year; (2) records exist for more than 500,000 wells (i.e., construction logs, measurements of depth to water, physical, chemical and bacteriological, analyses of water, and pumping records); and (3) that a number of State, Federal County, City and local water agencies are involved in the development, use, and control of the water obtained from (or put into) these wells.

To prevent the uncoordinated numbering of wells by numerous agencies which would result in confusion and the preparation of erroneous information, a single agency is responsible for the assignment of well numbers. The Department of Water Resources (DWR) has that responsibility and authority.

### The Well Numbering System

The State well numbering system is based on a rectangular system called the United States System of Surveying the Public Lands, commonly referred to as the Public Lands Survey, established by the Continental Congress in 1784. Under it all tracts of lands are tied to an initial point and identified as being in a township. A township is a square parcel of land six miles on each side. Its location is established as being so many six-mile units east or west of a north-south line running through the initial point (called the "principal meridian") and so many six-mile units north or south of an east-west line running through the point (called the "baseline"). In California there are three initial points and corresponding principal meridians and baselines. They are Mount Diablo, San Bernardino, and Humboldt, and we identify them by the letters M, S, and H respectively. The meridian lines parallel to, and east or west of, the principal meridian are called Range Lines. Lines parallel to, and north or south of, the baseline are known as Township Lines. Each township is described with respect to the initial point by its distance in numbers of six mile units and direction from that point i.e., north or south and east or west.

Every township is further divided into 36 parts called sections. A section is also described as a square parcel of land one mile on a side, each containing 640 acres. While this precision is customarily maintained, shortcomings in surveying techniques and the curvature of the Earth have resulted in some abbreviated or irregular sections. Spanish land grants which predate the public land surveys in California have not been subdivided in this manner. However, DWR in cooperation with the USGS has extended section lines on maps on which land grant boundaries appear and many extended section lines are published. DWR maintains an official file of these lines.

Such an existing grid system, familiar to agriculture, the real estate industry, surveyors and engineers is very useful for identifying "points on the ground" such as water wells. The State

well numbering system is an extension of the public land survey system and has been employed by DWR, USGS and other agencies for 50 years. Under it each well is assigned a unique number referred to as the State Well Number. The extension of the system involves dividing each section of land into sixteen 40-acre tracts. Once the well's location is established in the 40-acre tract it is assigned a sequence number. These sequence numbers are assigned in chronological order by DWR personnel. DWR maintains an index to prevent duplication.

#### Nomenclature and Notation: Examples

Following is an example of a State well number:

03S/04E-36N04S

Ignoring the slash and the hyphen the well numbers components are:

State Well Number	03S	04E	36	N	04	S
Township-----/	/	/	/	/	/	/
Range-----/	/	/	/	/	/	/
Section-----/	/	/	/	/	/	/
40-Acre Tract-----/	/	/	/	/	/	/
Sequence Number-----/	/	/	/	/	/	/
Base and Meridian-----/	/	/	/	/	/	/

Township is the third 36 square mile parcel of land (township) south of the initial point (T3S).

Range is the fourth 36 square mile parcel of land (township) east of the initial point (R4E).

Section is that parcel of land one mile square numbered 36 in township T3S/R4E.

Tract is that 40-acre parcel of land in section 36 lettered "N".

Sequence number 4 is the number assigned to this particular well in tract N of section 36 and it indicates that three other wells in this tract have been assigned numbers in the past.

Base and Meridian is that particular initial point, baseline and principal meridian to which this well is referenced, in this case S, the San Bernardino Base and Meridian.

#### How to Get Well Numbers Assigned

Agencies desiring well numbers should contact the district office of DWR in whose area the wells are situated. There are four district office locations; Red Bluff (Northern), Sacramento (Central), Fresno (San Joaquin), and Glendale (Southern). Addresses of these offices plus a list of the counties in each district area are attached. If you are uncertain as to which district office

to contact or you need additional assistance contact the Division of Local Assistance in Sacramento.

Your request for a State Well Number should be accompanied by:

1. A map of reasonably large scale or a sketch map showing the location of the wells with respect to prominent manmade features or natural landmarks and the distance to them. A most useful map is the standard USGS seven and one-half minute quadrangle topographic map with a scale of 1:24000 (2-1/2 inches = one mile).
2. An exact description of each individual well location including:
  - a. Address of the property (county, city or town, street or highway address).
  - b. If used, the name or number assigned to the well by its owner. (Agencies owning more than one well commonly identify each well by some designation.)
  - c. The township, range, and section (if known).
  - d. Direction and distance from the nearest city or town, roads, streets, canals, powerlines, or other identifier.
  - e. Its location with respect to existing wells (distance and direction).
3. A description of the well itself, i.e., anything that is known about the well:
  - owner
  - date of construction (reconstruction or modification)
  - driller
  - depth of well
  - casing material and its diameter
  - pump horsepower and manufacturer of pump and motor including serial number
  - utility company meter number

It is recognized that all this information may not be readily available for each well but the more there is the less the possibility of misnumbering and confusion at a later date.

DWR has for many years used a standardized form (DWR Form 429 "Well Data") for recording information for each well. Copies are available on request.

# INDEX TO TOWNSHIP AND RANGE SYSTEM OF CALIFORNIA

SCALE  
10 20 30 40 50 MILES

DIAGRAM OF  
A TOWNSHIP  
36 SECTIONS

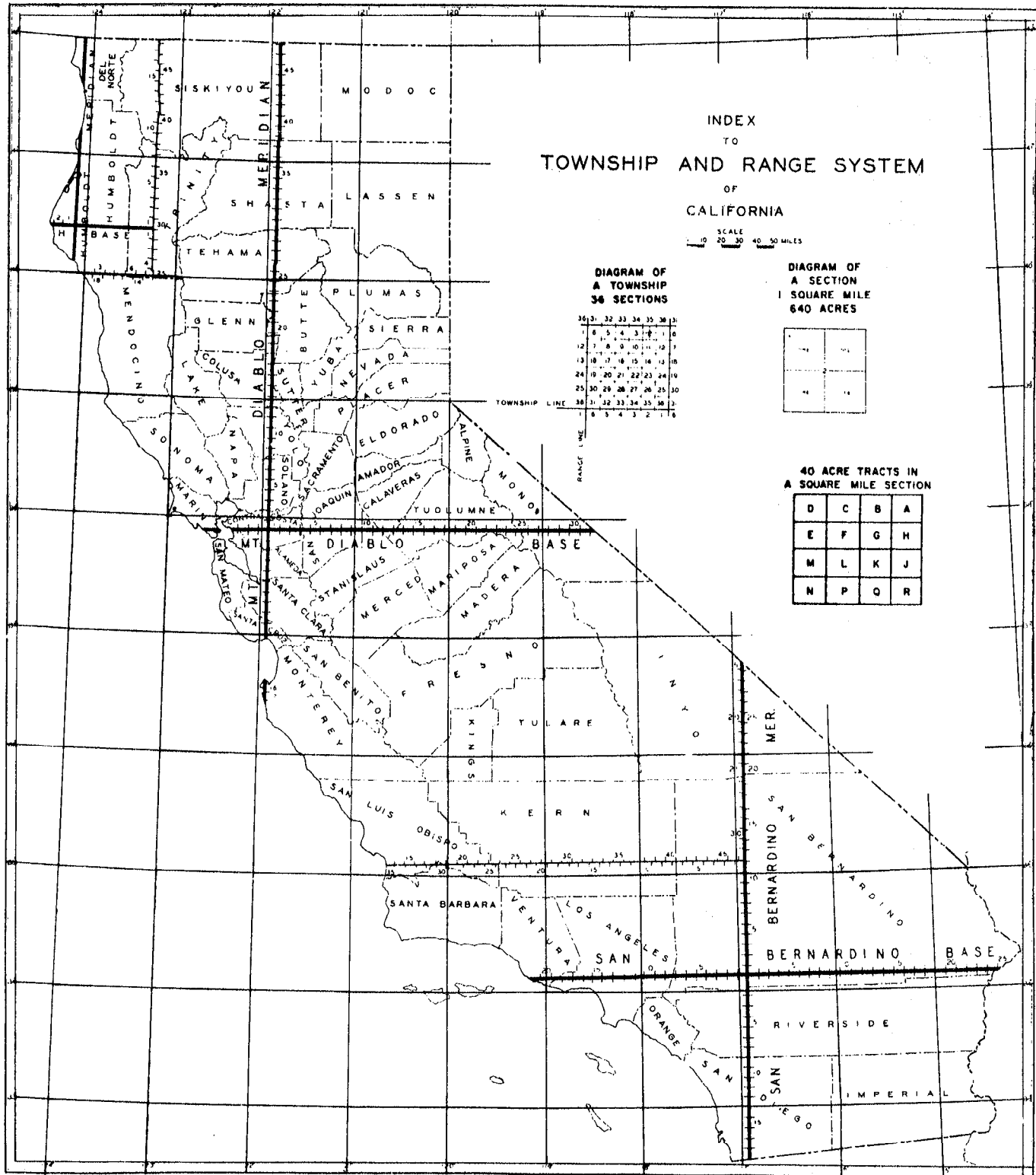
36	31	32	33	34	35	36	31
1	6	5	4	3	2	1	6
12	7	8	9	10	11	12	7
13	18	17	16	15	14	13	18
24	19	20	21	22	23	24	19
25	30	29	28	27	26	25	30
36	31	32	33	34	35	36	31
6	5	4	3	2	1	6	

DIAGRAM OF  
A SECTION  
1 SQUARE MILE  
640 ACRES

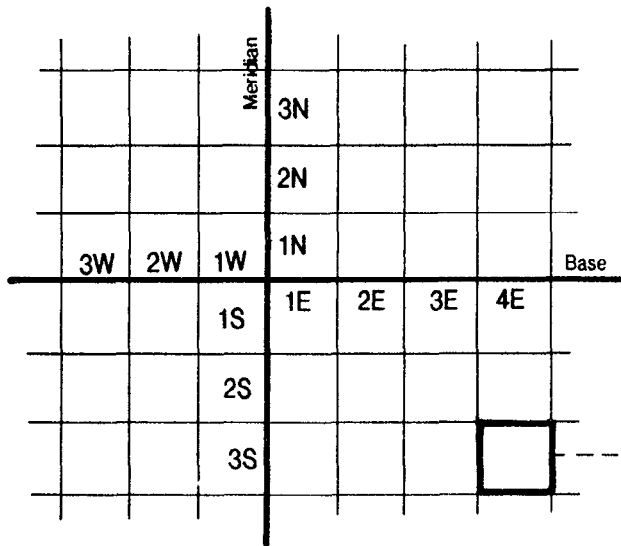
1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

40 ACRE TRACTS IN  
A SQUARE MILE SECTION

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R



# STATE WELL NUMBER 03S/04E-36N04S



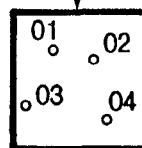
**SAN BERNARDINO BASE  
AND MERIDIAN**  
Township and Range  
Numbering System

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

**TOWNSHIP 03 SOUTH,  
RANGE 04 EAST**  
Section Numbering System

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

**SECTION 36**  
Tract Numbering System



**TRACT "N"**  
Well Numbering System  
and Location

**APPENDIX - F**

**ROUTINE DPR NOTIFICATIONS WHEN PESTICIDES ARE DETECTED IN GROUND  
WATER**

## Routine DPR Notifications When Pesticides Are Detected in Ground Water

The following parties are notified routinely when an active ingredient or breakdown product of a pesticide has been detected by DPR in a ground water sample collected from a well:

Parties	Notifications	
	Privately Owned Domestic and Irrigation Wells	Public Water Systems
Well Owner	Yes	Yes
County Agricultural Commissioner	Yes	Yes
County Environmental Health	Yes	Yes
County Health Officer	Yes	Yes
California Department of Health Services, Office of Drinking Water: Technical Programs Branch, Chief		Yes
California Department of Health Services, Office of Drinking Water: District Engineer		Yes



**APPENDIX - G**

**DEPARTMENT OF WATER RESOURCES - DISTRICT OFFICES**

DEPARTMENT OF WATER RESOURCES

DISTRICT OFFICES

NORTHERN DISTRICT

Post Office Box 607  
Red Bluff, CA 96080  
(2440 Main Street)  
(916) 527-6530

Butte  
Colusa  
Del Norte  
Glenn  
Humboldt  
Lake  
Lassen  
Modoc  
Plumas  
Shasta  
Siskiyou  
Tehama  
Trinity

CENTRAL DISTRICT

3251 "S" Street  
Sacramento, CA 95816-7017  
(916) 322-7164

Alameda  
Alpine  
Amador  
Calaveras  
Contra Costa  
El Dorado  
Marin  
Mendocino  
Mono\* (north of Mono Lake)  
Napa  
Nevada  
Placer  
Sacramento  
San Francisco  
San Joaquin  
San Mateo  
Santa Clara  
Santa Cruz  
Sierra  
Solano  
Sonoma  
Sutter  
Yolo  
Yuba

SAN JOAQUIN DISTRICT

3374 E. Shields Avenue  
Fresno, CA 93726-6990  
(209) 445-5481

Fresno  
Kern\* (from Sierra Nevada west)  
Kings  
Madera  
Mariposa  
Merced  
San Benito  
Santa Cruz  
Stanislaus  
Tuolumne  
Tulare  
Monterey

SOUTHERN DISTRICT

Post Office Box 29068  
Glendale, CA 91209-9068  
(818) 543-4600

Imperial  
Kern\* (east of Sierra Nevada)  
Los Angeles  
Mono\* (from Mono Lake south)  
Orange  
Riverside  
Santa Barbara  
San Bernardino  
San Luis Obispo  
Ventura

HEADQUARTERS

Division of Local Assistance  
1020 Ninth Street  
Sacramento, CA 95814  
(916) 327-8861

\* Counties are located in two districts.

**APPENDIX - H**

**DEPARTMENT OF WATER RESOURCES - WELL DATA, FORM 429**

# WELL DATA

DISTRICT \_\_\_\_\_

Owner \_\_\_\_\_ State No. \_\_\_\_\_  
Address \_\_\_\_\_ Other No. \_\_\_\_\_  
Tenant \_\_\_\_\_  
Address \_\_\_\_\_

Type of Well: Hydrograph ☐ Key ☐ Index ☐ Semiannual ☐

Location: County \_\_\_\_\_ Basin \_\_\_\_\_ No. \_\_\_\_\_

U.S.G.S. Quad. \_\_\_\_\_ Quad. No. \_\_\_\_\_

\_\_\_\_\_ 1/4 \_\_\_\_\_ 1/4 Section \_\_\_\_\_, Twp. \_\_\_\_\_, Rge. \_\_\_\_\_ MD  
SB Base & Meridian  
H

Description \_\_\_\_\_

Reference Point description \_\_\_\_\_

which is \_\_\_\_\_ ft. <sup>above</sup> land surface. Ground Elevation \_\_\_\_\_ ft.  
below

Reference Point Elev. \_\_\_\_\_ ft. Determined from \_\_\_\_\_

Well: Use \_\_\_\_\_ Condition \_\_\_\_\_ Depth \_\_\_\_\_ ft.

Casing, size \_\_\_\_\_ in., perforations \_\_\_\_\_

Measurements By: DWR ☐ USGS ☐ USBR ☐ County ☐ Irr. Dist. ☐ Water Dist. ☐ Cons. Dist. ☐

Chief Aquifer: Name \_\_\_\_\_ Depth to Top Aq. \_\_\_\_\_ Depth to Bot. Aq. \_\_\_\_\_

Type of Material \_\_\_\_\_ Perm. Rating \_\_\_\_\_ Thickness \_\_\_\_\_

Gravel Packed? Yes ☐ No ☐ Depth to Top Gr. \_\_\_\_\_ Depth to Bot. Gr. \_\_\_\_\_

Supp. Aquifer \_\_\_\_\_ Depth to Top Aq. \_\_\_\_\_ Depth to Bot. Aq. \_\_\_\_\_

Driller \_\_\_\_\_

Date drilled \_\_\_\_\_ Log, filed \_\_\_\_\_ open (1) \_\_\_\_\_ confidential (2) \_\_\_\_\_

Equipment: Pump, type \_\_\_\_\_ make \_\_\_\_\_

Serial No. \_\_\_\_\_ Size of discharge pipe \_\_\_\_\_ in. Water Analysis: Min. (1) \_\_\_\_\_ San. (2) \_\_\_\_\_ H.M. (3) \_\_\_\_\_

Power, Kind \_\_\_\_\_ Make \_\_\_\_\_ Water Levels available: Yes (1) \_\_\_\_\_ No \_\_\_\_\_

H. P. \_\_\_\_\_ Motor Serial No. \_\_\_\_\_ Period of Record: Begin \_\_\_\_\_ End \_\_\_\_\_

Elec. Meter No. \_\_\_\_\_ Transformer No. \_\_\_\_\_ Collecting Agency: \_\_\_\_\_

Yield \_\_\_\_\_ G.P.M. Pumping level \_\_\_\_\_ ft. Prod. Rec. (1) \_\_\_\_\_ Pump Test (2) \_\_\_\_\_ Yield (3) \_\_\_\_\_

SKETCH



REMARKS

Recorded by: \_\_\_\_\_

Date \_\_\_\_\_

**APPENDIX - I**  
**CONVERSION TABLES**

## TABLES OF WEIGHTS AND MEASURES

### Linear Measure

1 inch	=	2.54	centimeters
12 inches = 1 foot	=	0.3048	meter
3 feet = 1 yard	=	0.9144	meter
5½ yards or 16½ feet = 1 rod (or pole or perch)	=	5.029	meters
40 rods = 1 furlong	=	201.17	meters
8 furlongs or 1,760 yards or 5,280 feet = 1 (statute) mile	=	1,609.3	meters
3 miles = 1 (land) league	=	4.83	kilometers

---

### Square Measure

1 square inch	=	6.452	square centimeters
144 square inches = 1 square foot	=	929	square centimeters
9 square feet = 1 square yard	=	0.8361	square meter
30¼ square yards = 1 square rod (or square pole or square perch)	=	25.29	square meters
160 square rods or 4,840 square yards or 43,560 square feet = 1 acre	=	0.4047	hectare
640 acres = 1 square mile	=	259	hectares or 2.59 square kilometers

---

### Cubic Measure

1 cubic inch	=	16.387	cubic centimeters
1,728 cubic inches = 1 cubic foot	=	0.0283	cubic meter
27 cubic feet = 1 cubic yard	=	0.7646	cubic meter
(in units for cordwood, etc.)			
16 cubic feet = 1 cord foot			
8 cord feet = 1 cord	=	3.625	cubic meters

---

### Chain Measure

(for Gunter's, or surveyor's chain)			
7.92 inches = 1 link	=	20.12	centimeters
100 links or 66 feet = 1 chain	=	20.12	meters
10 chains = 1 furlong	=	201.17	meters
80 chains = 1 mile	=	1,609.3	meters
(for engineer's chain)			
1 foot = 1 link	=	0.3048	meter
100 feet = 1 chain	=	30.48	meters
52.8 chains = 1 mile	=	1,609.3	meters

### **Apothecaries' Fluid Measure**

1 minim	=	0.0038 cubic inch	=	0.0616 milliliter
60 minims	= 1 fluid dram	=	0.2256 cubic inch	= 3.6966 milliliters
8 fluid drams	= 1 fluid ounce	=	1.8047 cubic inches	= 0.0296 liter
16 fluid ounces	= 1 pint	=	28.875 cubic inches	= 0.4732 liter

---

### **Circular (or Angular) Measure**

60 seconds (")	=	1 minute (')
60 minutes	=	1 degree (°)
90 degrees	=	1 quadrant or 1 right angle
4 quadrants or 360 degrees	=	1 circle

---

### **Avoirdupois Weight**

(The grain, equal to 0.0648 gram, is the same in all three tables of weight)

1 dram or 27.34 grains	=	1.772	grams
16 drams or 437.5 grains = 1 ounce	=	28.3495	grams
16 ounces or 7,000 grains = 1 pound	=	453.59	grams
100 pounds = 1 hundredweight	=	45.36	kilograms
2,000 pounds = 1 ton	=	907.18	kilograms
In Great Britain, 14 pounds (6.35 kilograms) = 1 stone			
112 pounds (50.80 kilograms) = 1 hundredweight			
2,240 pounds (1,016.05 kilograms) = 1 long ton.			

---

### **Troy Weight**

(The grain, equal to 0.0648 gram, is the same in all three tables of weight)

3,086 grains = 1 carat	=	200	milligrams
24 grains = 1 pennyweight	=	1.5552	grams
20 pennyweights or 480 grains = 1 ounce	=	31.1035	grams
12 ounces or 5,760 grains = 1 pound	=	373.24	grams

---

### **Apothecaries' Weight**

(The grain, equal to 0.0648 gram, is the same in all three tables of weight)

20 grains = 1 scruple	=	1.296	grams
3 scruples = 1 dram	=	3.888	grams
8 drams or 480 grains = 1 ounce	=	31.1035	grams
12 ounces or 5,760 grains = 1 pound	=	373.24	grams

## THE METRIC SYSTEM

### Linear Measure

10 millimeters	= 1 centimeter	= 0.3937 inch
10 centimeters	= 1 decimeter	= 3.937 inches
10 decimeters	= 1 meter	= 39.37 inches or 3.28 feet
10 meters	= 1 decameter	= 393.7 inches
10 decameters	= 1 hectometer	= 328 feet 1 inch
10 hectometers	= 1 kilometer	= 0.621 mile
10 kilometers	= 1 myriameter	= 6.21 miles

---

### Square Measure

100 square millimeters	= 1 square centimeter	= 0.15499 square inch
100 square centimeters	= 1 square decimeter	= 15.499 square inches
100 square decimeters	= 1 square meter	= 1,549.9 square inches or 1.196 square yards
100 square meters	= 1 square decameter	= 119.6 square yards
100 square decameters	= 1 square hectometer	= 2.471 acres
100 square hectometers	= 1 square kilometer	= 0.386 square mile

---

### Land Measure

1 square meter	= 1 centiare	= 1,549.9 square inches
100 centiares	= 1 are	= 119.6 square yards
100 ares	= 1 hectare	= 2.471 acres
100 hectares	= 1 square kilometer	= 0.386 square mile

---

### Volume Measure

1,000 cubic millimeters	= 1 cubic centimeter	= .06102 cubic inch
1,000 cubic centimeters	= 1 cubic decimeter	= 61.02 cubic inches
1,000 cubic decimeters	= 1 cubic meter	= 35.314 cubic feet

(the unit is called a *stere* in measuring firewood)

---

### Capacity Measure

10 milliliters	= 1 centiliter	= .338 fluid ounce
10 centiliters	= 1 deciliter	= 3.38 fluid ounces
10 deciliters	= 1 liter	= 1.0567 liquid quarts or 0.9081 dry quart
10 liters	= 1 decaliter	= 2.64 gallons or 0.284 bushel
10 decaliters	= 1 hectoliter	= 26.418 gallons or 2.838 bushels
10 hectoliters	= 1 kiloliter	= 264.18 gallons or 35.315 cubic feet

---

### Weights

10 milligrams	= 1 centigram	= 0.1543 grain
10 centigrams	= 1 decigram	= 1.5432 grains
10 decigrams	= 1 gram	= 15.432 grains
10 grams	= 1 decagram	= 0.3527 ounce
10 decagrams	= 1 hectogram	= 3.5274 ounces
10 hectograms	= 1 kilogram	= 2.2046 pounds
10 kilograms	= 1 myriagram	= 22.046 pounds
10 myriagrams	= 1 quintal	= 220.46 pounds
10 quintals	= 1 metric ton	= 2,204.6 pounds



### Surveyor's (Square) Measure

625 square links	= 1 square pole	= 25.29	square meters
16 square poles	= 1 square chain	= 404.7	square meters
10 square chains	= 1 acre	= 0.4047	hectare
640 acres	= 1 square mile or 1 section	= 259	hectares or 2.59 square kilometers
36 square miles	= 1 township	= 9,324.0	hectares or 93.24 square kilometers

---

### Nautical Measure

6 feet	= 1 fathom	= 1.829 meters
100 fathoms	= 1 cable's length (ordinary)	
(In the U.S. Navy 120 fathoms or 720 feet = 1 cable's length; in the British Navy, 608 feet = 1 cable's length.)		
10 cables' lengths	= 1 nautical mile (6.076.10333 feet, by international agreement in 1954)	= 1.852 kilometers
1 nautical mile	= 1.1508 statute miles (the length of a minute of longitude at the equator)	
(Also called geographical, sea, or air mile, and, in Great Britain, Admiralty mile.)		
3 nautical miles	= 1 marine league (3.45 statute miles)	= 5.56 kilometers
60 nautical miles	= 1 degree of a great circle of the earth	

---

### Dry Measure

1 pint	= 33.60 cubic inches	= 0.5505 liter
2 pints = 1 quart	= 67.20 cubic inches	= 1.1012 liters
8 quarts = 1 peck	= 537.61 cubic inches	= 8.8096 liters
4 pecks = 1 bushel	= 2,150.42 cubic inches	= 35.2383 liters

1 British dry quart = 1.032 U.S. dry quarts

According to United States government standards, the following are the weights avoirdupois for single bushels of the specified grains: for wheat, 60 pounds; for barley, 48 pounds; for oats, 32 pounds; for rye, 56 pounds; for corn, 56 pounds. Some States have specifications varying from these.

---

### Liquid Measure

1 gill	= 4 fluid ounces	= 7.219 cubic inches	= 0.1183 liter
(see next table)			
4 gills	= 1 pint	= 28.875 cubic inches	= 0.4732 liter
2 pints	= 1 quart	= 57.75 cubic inches	= 0.9463 liter
4 quarts	= 1 gallon	= 231 cubic inches	= 3.7853 liters

The British imperial gallon (4 imperial quarts) = 277.42 cubic inches = 4.546 liters. The barrel in Great Britain equals 36 imperial gallons, in the United States, usually 31½ gallons.